Center Independent Research & Development: LaRC IRAD

FLEET for Unseeded Velocity Measurements in All Speed Regimes

Completed Technology Project (2013 - 2014)

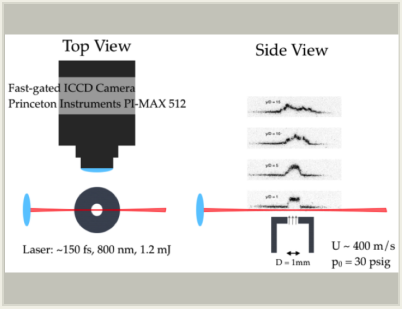
Project Introduction

Apply femtosecond laser electronic excitation tagging (FLEET, a promising molecular-based measurement technique, in wind tunnels using an ultrafast laser to accurately measures the gas flow velocity in wind tunnels where few or no suitable capabilities currently exist

FLEET uses a 100 fs laser to excite a multi-photon process that makes the gas (N2 or air) glow. Images of the glowing gas taken at set time intervals allow the gas velocity to be measrued. FLEET has the following advantageous features compared with existing measurement techniques: (1) it excites naturally-present N2 so it can be used in N2 or air flows - not requiring additional gas or particle seeding; (2) both excitation and detection are in the visible spectral range, so special UV or IR windows are not required; (3) only a single laser and camera is required which simplifies setup and operation; (4) the technique has been shown to work over a large range of pressures and is therefore amenable to a wide range of speed regimes (subsonic to hypersonic); and (5) the technique can easily be extended to measure thousands of samples per second. The technique is thus applicable to a much wider range of wind tunnels than any other velocity measurement technique currently being developed at NASA. For comparison, one currently state-of-the-art technique, NO2 molecular tagging velocimetry, requires three lasers, requires seeding the flow with toxic NO2 gas, requires expensive UV-grade fused silica windows on two sides of the wind tunnel and is limited to about 10 measurements per second.

Anticipated Benefits

FLEET will allow quantitative velocity data to be obtained in many NASA facilities where such measurements are not possible, or are very difficult. Insight into the fluid behavior as the gas flows over the test vehicles will also be obtained: FLEET can identify and quantify laminar-to-turbulent transition, flow separations, shear layers, plumes, etc. Improved understanding of these phenomena will reduce uncertainties in computational codes used to predict flight and to design vehicles, ultimately resulting in improved vehicle efficiency, safety, and design robustness



Project Image FLEET for Unseeded Velocity Measurements in All Speed Regimes

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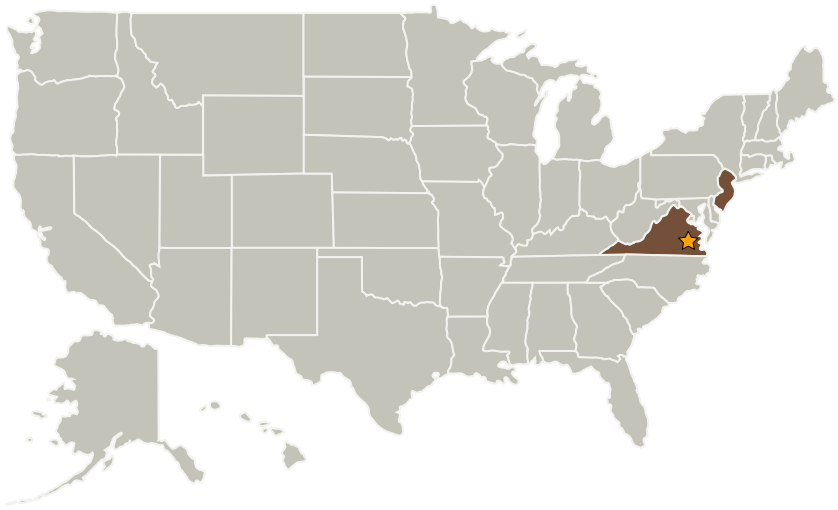
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Langley Research Center(LaRC)	Lead Organization	NASA Center	Hampton, Virginia

Co-Funding Partners	Type	Location
Princeton University	Academia	Princeton, New Jersey

Primary U.S. Work Locations	
New Jersey	Virginia

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Langley Research Center (LaRC)

Responsible Program:

Center Independent Research & Development: LaRC IRAD

Project Management

Program Manager:

Julie A Williams-byrd

Project Manager:

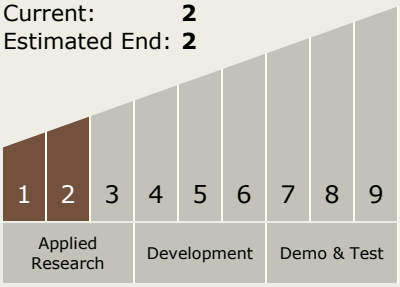
Paul M Danehy

Principal Investigator:

Paul M Danehy

Technology Maturity (TRL)

Start: **1**
Current: **2**
Estimated End: **2**



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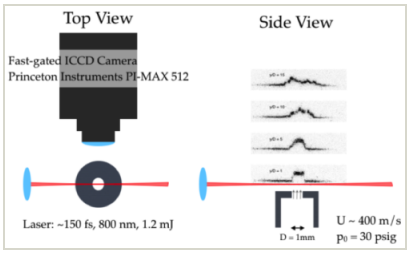
Images



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Project Image FLEET for Unseeded Velocity Measurements in All Speed Regimes
(https://techport.nasa.gov/image/2290)

Technology Areas

Primary:

- TX15 Flight Vehicle Systems
  - TX15.1 Aerosciences
    - TX15.1.8 Ground and Flight Test Technologies